

## **Resource Allocation Planning and Scheduling Office**

### **International Solar Terrestrial Physics (ISTP) Missions Extension Impact Assessment Report on the 34BWG-1 Subnet**

**February 18, 2004**

#### **Study Description**

This report describes and reports on a loading study for the period 2009 through 2010 that assesses the impact on the 34-meter beam wave guide-1 subnet (34BWG-1) as a result of extending and placing the S-band International Solar Terrestrial Physics (ISTP) missions managed out of Goddard Space Flight Center (GSFC) on the subnet. The ISTP missions are currently tracked on the Deep Space Network (DSN) 26-meter subnet and on the 34-meter High Speed Beam waveguide (34HSB) antenna at Goldstone. This 26-meter subnet (Deep Space Station-16, 46, and 66) and the 34HSB (Deep Space Station-27) are expected to be decommissioned at the end of 2008, following the end of the current ISTP extensions in effect through 2008. The study's main objective was to determine the possibility of supporting these S-band missions on the 34-meter antennas, in particular, on the 34BWG-1 subnet which is the only 34-meter subnet currently having S-band capability. The questions the study attempts to answer include:

1. Can the 34BWG1 accommodate the projected tracking loads from On-going, Advanced Planning, and Future Missions as they are known today with the addition of the ISTP missions without appreciable loss of tracking time to these missions (greater than 10-to-15% unsupportable time)?
2. If the ISTP missions are placed on the 34BWG-1, and prime missions receive priority in tracking, then will the ISTP missions suffer significant tracking time loss (greater than 15-to-30% unsupportable time)?
3. IF ISTP missions lose significant tracking support, then what levels of tracking support can they expect to receive during this period (2009 through 2010)?

No cost determinations were required in the study.

#### **Approach and Assumptions**

The approach taken in the study was to analyze first, the tracking loads anticipated on the 34BWG-1 subnet as a result of just the On-going, Advanced Planning, and Future missions as they are known today for the period 2009 through 2010. Then second, analyze the tracking loads on the 34BWG-1 with the ISTP missions added into the mix. The missions included were the Advanced Composition Explorer (ACE), Solar and Heliospheric Observatory (SOHO), WIND, GEOTAIL, and Chandra X-Ray Observatory (CXO). The POLAR mission was assumed to have ended, and therefore was not included. No consideration was given to extensions for WMAP, INTEGRAL or IMAGE in the study.

The charts created by the model have the following assumptions:

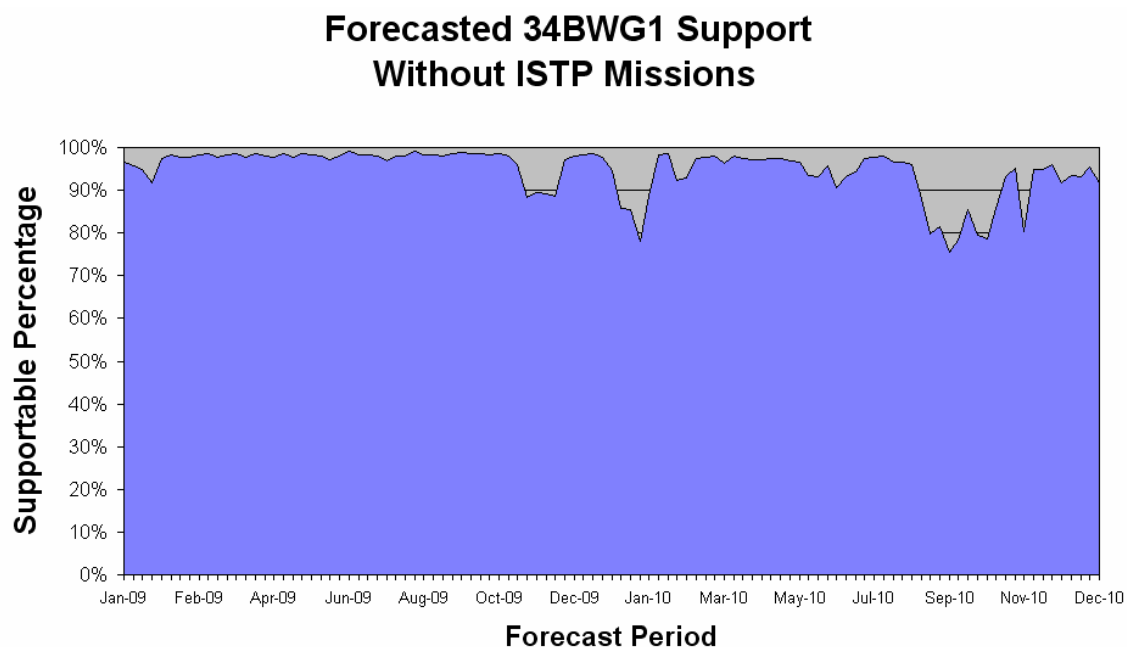
- The charts have resolution to the week
- ACE, SOHO and WIND will all be at the Sun-Earth Lagrange Point 1 (L1 halo orbit) and cumulatively will provide a constant load and conflict with missions including DSS Maintenance whose View Period overlaps with the Daylight View Period.

- Supportable percentage is that percentage of the missions requested hours (not taking whole tracks into account) that is supportable by the DSN on the 34BWG-1 subnet. This inherently assumes that some tracks that are supported are shorter than requested.
- The ISTP missions have a lower priority for support as extended missions and therefore receive support accordingly.
- The support forecasted uses the RAPSO database in effect for the February 2004 Resource Allocation Review Board (RARB).
- Tracking requirements for the ISTP missions are their 2005 tracking requirements replicated for 2009 and 2010.
- No critical events are discussed or considered, nor are Future mission events explained.
- The Future missions considered are those listed on the RAPSO webpage (<http://rapweb.jpl.nasa.gov>) as of February 3, 2004. A listing of the Future mission set along with the On-going and Advanced Planning Missions are included in the appendix.
- Advanced Planning and Future missions are modeled with view periods (where known or expected, for example, if the mission is known to be going to L2 or a planet, then the View Period for L2 or the planet is used).
- Advanced Planning and Future missions are modeled with anticipated tracking requirements using existing missions of potentially similar tracking requirements.

### **Assessment**

#### **Overall 34BWG-1 Subnet Loading - 2009 through 2010 without the ISTP Missions**

Figure 1 shows the forecasted supportable percentage of requested tracking hours on the 34BWG-1 subnet for the On-going, Advanced Planning, and Future Missions sets. Except for three periods (October 2009, January 2010, and August 2010 through November 2010), support

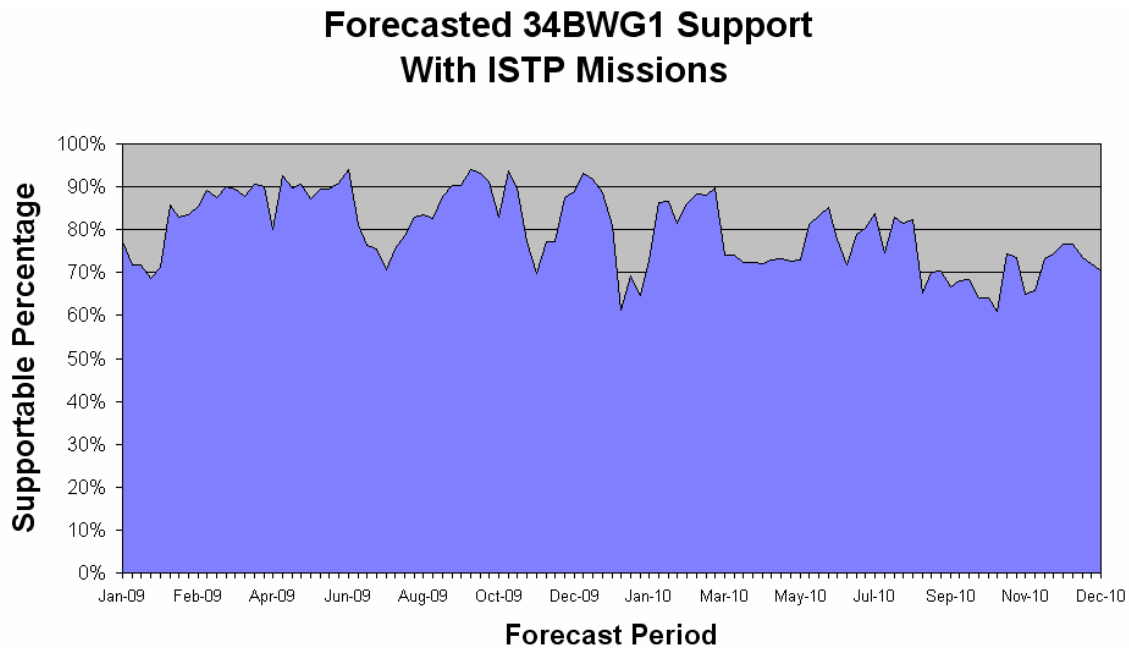


**Figure 1. Forecasted Supportable Percentage on the 34BWG-1 Subnet without the ISTP Missions**

for the missions sets and their requested tracking requirements appear to exceed 95% supportable in this period. The drop in support in the three periods identified, are due to anticipated launch requirements that may or may not be overstated for the Future Missions set. In general, without the ISTP missions on the subnet, the subnet support for the mission sets considered appears doable without severe contention or conflicts at this time.

#### **Overall 34BWG-1 Subnet Loading - 2009 through 2010 with the ISTP Missions**

When ACE, SOHO, WIND, CXO, and GEOTAIL are added into the mix of missions modeled, support is clearly impacted for all missions as shown in Figure 2. Support drops significantly



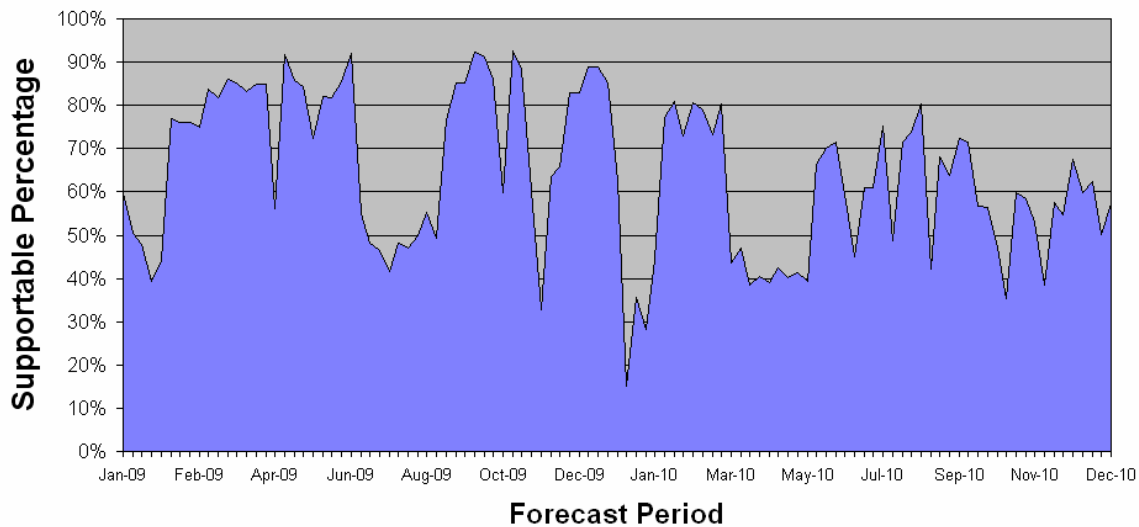
**Figure 2. Forecasted Supportable Percentage on the 34BWG-1 Subnet With the ISTP Mission Requirements Included**

for all missions with numerous periods where supportable percentages for all missions ranges between 70%-to-80%. These drops coincide with the Resource Allocation Review Board's (RARB) definition for severe periods of contention (31%-to-45% unsupportable time). Such periods are October-November 2009, January 2010, and October 2010. The remainder of the 2009-2010 period meets the RARB's definition for low (workable <15%) to moderate (15%-to-30%) contention .

#### **Expected Support for ACE Tracking Requirements - 2009 through 2010**

In Figure 3 the forecasted supportable percentage of ACE's requested tracking hours for the period 2009 through 2010 if their tracking requirements remain the same or similar to their 2005 tracking requirements. The impact to ACE appears to be severe for most of the two year period and drops to less than 30% during the modeled launch period (January 2010) for some of the Future Missions. Whether these impacts will be as severe as shown depends a great deal on which Future Missions get approved and when they are actually launched.

### ACE Forecasted 34BWG1 Support

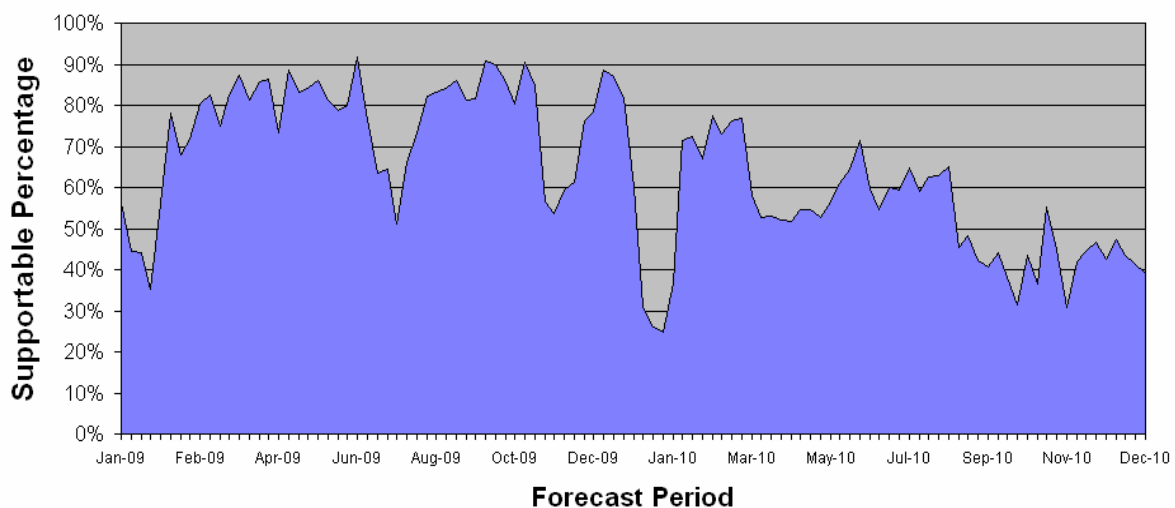


**Figure 3. ACE's Forecasted Support Percentage for the Period 2009-2010**

#### **Expected Support for SOHO Tracking Requirements - 2009 through 2010**

Like Figure 3, Figure 4 shows the forecasted supportable percentage of SOHO's requested tracking hours for the period 2009 through 2010 if their tracking requirements remain the same or similar to their 2005 tracking requirements. The impact to SOHO is likewise severe for most of the two year period and drops to less than 30% during the Future Missions modeled launch period in January 2010.

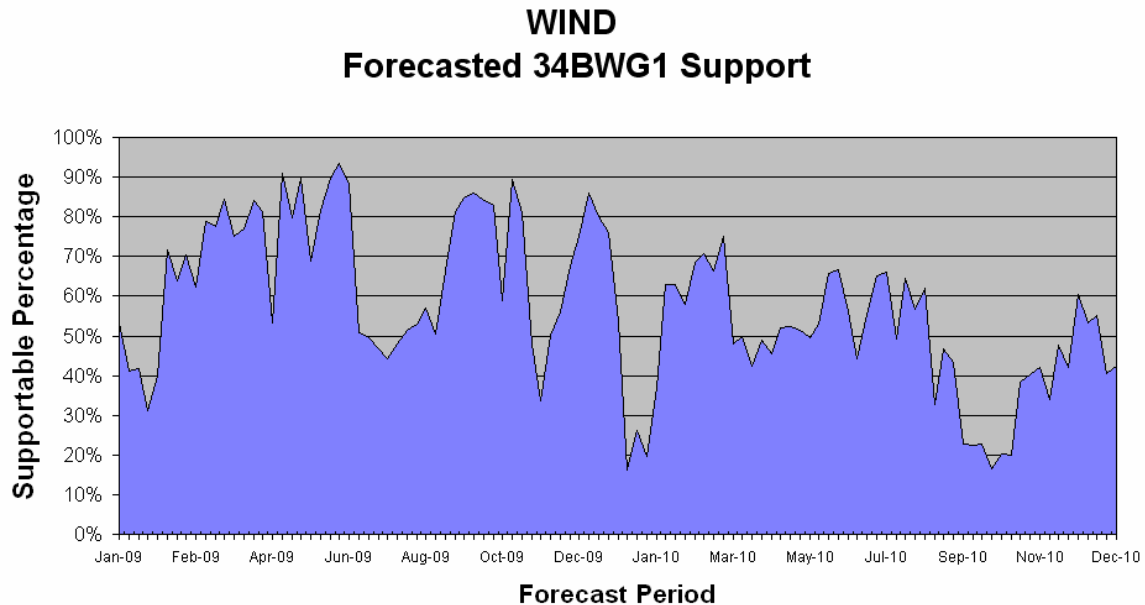
### SOHO Forecasted 34BWG1 Support



**Figure 4. SOHO's Forecasted Support Percentage for the Period 2009-2010**

### Expected Support for WIND Tracking Requirements - 2009 through 2010

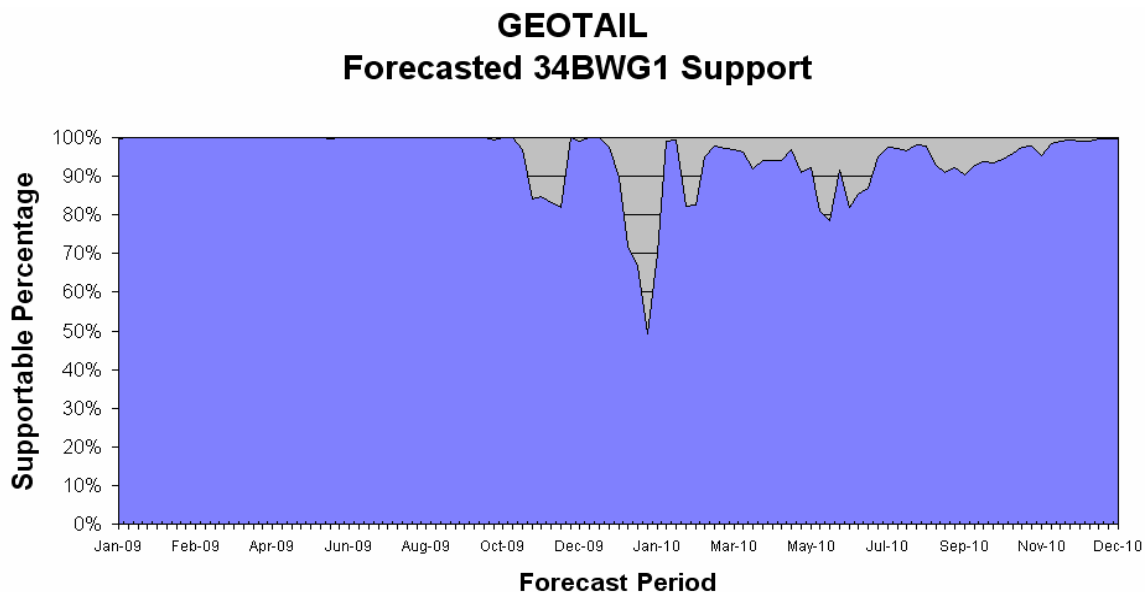
Like Figure 4, Figure 5 shows the forecasted supportable percentage of WIND's requested tracking hours for the period 2009 through 2010 if their tracking requirements remain the same or similar to their 2005 tracking requirements. The impact to WIND is severe throughout the entire period. In 2010, the severity is such that several periods (January 2010 and September-October 2010), support for WIND is expected to drop below 20% of its requested tracking time.



**Figure 5. WIND's Forecasted Support Percentage for the Period 2009-2010**

### Expected Support for GEOTAIL Tracking Requirements - 2009 through 2010

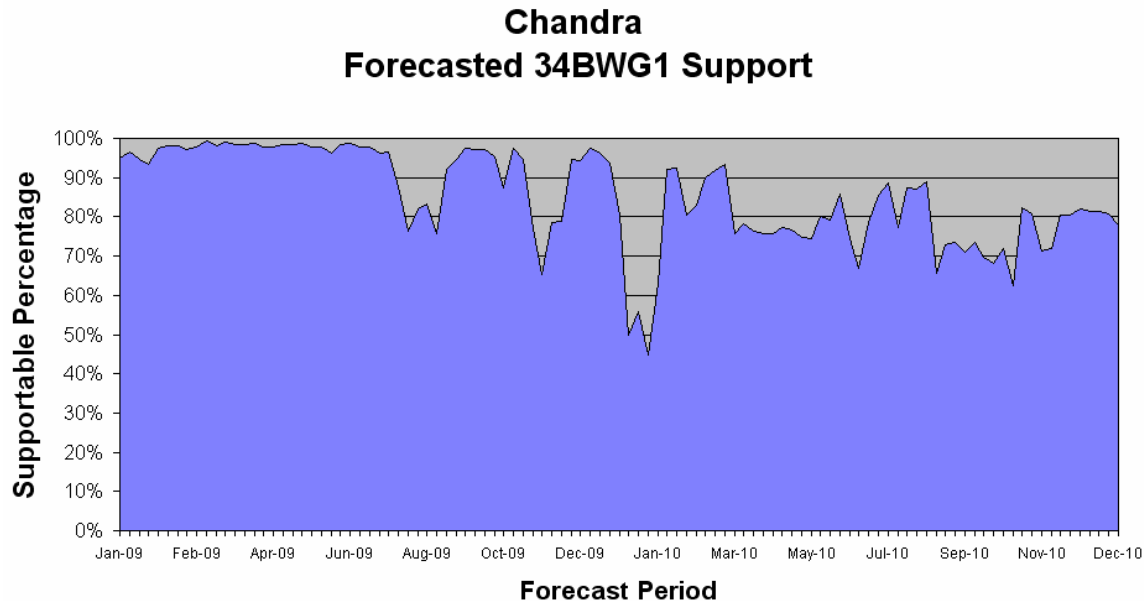
In Figure 6, the overall support for GEOTAIL in 2009 through 2010 appears nominal except for the modeled periods where Future Mission launches are placed (January 2010). Support for GEOTAIL on the 34BWG-1 appears nominal with a few periods of moderate contention in 2010.



**Figure 6. GEOTAIL's Forecasted Support Percentage for the Period 2009-2010**

### Expected Support for Chandra Tracking Requirements - 2009 through 2010

In Figure 7, like the preceeding figures shows the overall support for Chandra in 2009 through 2010. Support appears nominal except for the modeled periods where Future Mission launches are placed (i.e., January 2010). Like WIND and GEOTAIL, support for Chandra on the 34BWG-1 appears nominal throughout 2009 with periods of moderate contention in 2010.



**Figure 7. Chandra's Forecasted Support Percentage for the Period 2009-2010**

### Conclusions

It is clear from this level of analysis that placing the ISTP missions up on the 34BWG1 after 2008 will have significant impact to the On-going, Advanced Planning and Future Projects expecting to use this subnet. These missions can expect to lose an additional 10-to-20% of their supportable time during the period of study (2009-2010). Periods exist where their tracking time may be reduced by as much as 30% for long periods in 2010.

The DSN can accommodate additional loads on a subnet (question 1), but not without increased contention and reductions of greater than 15% for On-going, Advanced Planning, and Future Missions' requested tracking time. Additionally, the ISTP missions placed on the 34BWG1 will routinely suffer significant tracking time loss comparable to moderate, severe, and extreme as defined for periods of contention by the RARB (questions 2 and 3).

It appears that alternative tracking resources need to be provided or continued operation of the 26-meter subnet is suggested if these missions are extended.

## APPENDIX

# DSN User / Mission Planning Set

## 2004 - 2014

ONGOING/PLANNED PROJECTS				
Project	Acronym	Launch or Start	EOPM	EOEM
DSN Antenna Calibration	DSN	--	--	--
DSS Maintenance	DSS	--	--	--
European VLBI Network	EVN	--	--	--
Ground Based Radio Astronomy	GBRA	--	--	--
Reference Frame Calibration	DSN	--	--	--
Space Geodesy	SGP	--	--	--
Voyager 2	VGR2	08/20/77	10/15/89	09/30/07
Voyager 1	VGR1	09/05/77	12/31/80	09/30/07
Goldstone Solar System Radar	GSSR	04/01/85	--	--
Ulysses	ULYS	10/06/90	09/11/95	03/31/08
Geotail	GTL	07/24/92	07/24/95	12/31/08



# DSN User / Mission Planning Set (cont.)

**2004 - 2014**

## ONGOING/PLANNED PROJECTS

Project	Acronym	Launch or Start	EOPM	EOEM
Wind	WIND	11/01/94	11/01/97	12/31/08
SOHO	SOHO	12/02/95	05/02/98	12/31/08
Polar	POLR	02/22/96	08/23/97	12/31/08
Gravity Probe B (non Spacecraft support)	GPB	06/01/96	05/30/05	TBD
Mars Global Surveyor	MGS	11/07/96	02/01/01	01/03/08
Advance Composition Explorer	ACE	08/25/97	02/01/01	09/30/07
Cassini	CAS	10/15/97	06/30/08	06/30/10
Nozomi (Planet-B)	NOZO	07/03/98	12/15/03	- - -
Stardust	SDU	02/07/99	01/14/06	- - -
Chandra X-ray Observatory	CHDR	07/23/99	07/24/09	07/24/14
Imager for Magnetopause-to-Aurora Global Exploration	IMAG	03/25/00	05/30/02	09/30/07
Cluster 2 - S/C #2 (Samba)	CLU2	07/16/00	02/15/03	02/28/06

# DSN User / Mission Planning Set (cont.)

**2004 - 2014**

## ONGOING/PLANNED PROJECTS

Project	Acronym	Launch or Start	EOPM	EOEM
Cluster 2 - S/C #3 (Rumba)	CLU3	07/16/00	02/15/03	02/28/06
Cluster 2 - S/C #1 (Salsa)	CLU1	08/09/00	02/15/03	02/28/06
Cluster 2 - S/C #4 (Tango)	CLU4	08/09/00	02/15/03	02/28/06
2001 Mars Odyssey	M01O	04/07/01	08/24/04	05/29/08
Wilkinson Microwave Anisotropy Probe	WMAP	06/30/01	10/01/03	10/01/07
Genesis	GNS	08/08/01	09/08/04	- - -
Advanced Tracking and Observational Techniques (ATOT)	MEGA	02/01/02	12/31/08	- - -
International Gamma Ray Astrophysics Lab	INTG	10/17/02	12/18/04	12/31/08
Hayabusa (MUSES - C)	MUSC	05/09/03	06/05/07	- - -
Mars Express Orbiter	MEX	06/02/03	02/11/06	08/03/08
Spirit (Mars Exploration Rover - A)	MER2	06/10/03	04/06/04	05/11/04
Opportunity (Mars Exploration Rover - B)	MER1	07/07/03	04/27/04	06/15/04

## DSN User / Mission Planning Set (cont.)

### 2004 - 2014

#### ONGOING/PLANNED PROJECTS

Project	Acronym	Launch or Start	EOPM	EOEM
Spitzer Space Telescope (SIRTF)	STF	08/25/03	02/25/06	08/23/08
Rosetta	ROSE	02/26/04	12/31/15	- - -
Messenger	MSGR	05/11/04	04/06/10	- - -
Lunar - A	LUNA	08/30/04	04/11/05	- - -
Deep Impact	DIF	12/30/04	08/05/05	- - -
Space Technology 5	ST5	06/27/05	02/27/05	TBD
Mars Reconnaissance Orbiter	MRO	08/10/05	12/31/10	12/31/15
Stereo Ahead	STA	02/11/06	05/15/08	- - -
Stereo Behind	STB	02/11/06	05/15/08	- - -
New Horizons	NHPC	01/10/06	04/17/16	TBD
Dawn	DAWN	06/17/06	07/26/15	TBD

## DSN User / Mission Planning Set (cont.)

### 2004 - 2014

ADVANCED PLANNING PROJECTS					
Project	Acronym	Launch or Start	EOPM	EOEM	
SELENE	SELE	07/23/05	09/30/06	TBD	
Venus Express	VEX	10/26/05	08/19/07	TBD	
Phoenix Scout	PHX	08/09/07	11/04/08	TBD	
Kepler	KPLR	10/01/07	09/26/11	TBD	
Mars Telecommunications Orbiter 2009	M09T	09/07/09	09/07/16	09/07/20	
Mars Science Laboratory 2009	M09L	10/25/09	03/04/12	TBD	
Space Interferometry Mission	SIM	12/31/09	06/30/20	TBD	
James Webb Space Telescope	JWST	08/01/11	07/31/16	TBD	
Mars Placeholder 2011	M11S	10/30/11	09/10/14	TBD	
Mars Placeholder 2013	M13O	11/28/13	08/21/16	TBD	

# DSN User / Future Mission Planning Set

## 2006 - 2030

FUTURE NASA PROJECTS				
Project	Code S Theme	Launch or Start	EOPM	EOEM
Laser Interferometer Space Antenna (LISA)	SEU	06/01/11	07/01/16	07/01/21
Inflation Probe	SEU	09/01/18	09/01/22	--
Constellation-X (A Set)	SEU	12/01/13	01/31/18	01/31/23
Constellation-X (B Set)	SEU	12/01/14	01/31/18	01/31/23
Dark Energy Probe	SEU	09/05/15	09/02/18	09/02/20
Black Hole Finder Probe	SEU	06/01/21	07/01/24	--
Big Bang Observer	SEU	07/01/26	07/01/31	07/01/36
Black Hole Imager	SEU	01/31/26	01/31/31	01/01/36
Discovery Mission 11	ASO	09/01/08	12/01/13	12/01/15
Terrestrial Planet Finder (TPF)	ASO	04/01/14	03/31/19	03/31/24
Single Aperture Far-Infrared Observatory	ASO	06/03/17	06/02/22	06/02/27

# DSN User / Future Mission Planning Set (cont.)

**2006 - 2030**

## FUTURE NASA PROJECTS

Project	Code S Theme	Launch or Start	EOPM	EOEM
Discovery Mission 13	ASO	04/01/12	03/31/17	--
Space Ultraviolet/Optical Telescope	ASO	01/01/21	12/31/25	01/31/31
Life Finder	ASO	04/01/24	04/01/29	04/01/34
Planet Imager	ASO	04/01/29	04/01/34	04/01/39
Discovery Mission 15	ASO	01/01/16	12/31/20	--
South Pole Aitken Basin Sample Return *	ESS	03/08/11	08/08/11	--
Mars Scouts 2011	ESS	10/30/11	09/10/14	--
Discovery Mission 12	ESS	04/01/10	03/31/15	--
Venus In-situ Explorer (VISE) *	ESS	04/01/15	03/31/18	--
Comet Surface Sample Return (CSSR) *	ESS	07/15/18	09/20/23	--
Jupiter Icy Moons Tour/Orbiter	ESS	04/01/11	03/31/21	--
Discovery Mission 14	ESS	09/01/14	08/31/19	--

# DSN User / Future Mission Planning Set (cont.)

**2006 - 2030**

## FUTURE NASA PROJECTS

Project	Code S Theme	Launch or Start	EOPM	EOEM
Mars Scouts 2014	ESS	12/27/13	08/21/16	--
Mars Long Lived Lander Network	ESS	02/20/16	01/01/18	01/01/19
Jupiter Polar Orbiter with Probes	ESS	01/01/16	10/25/30	--
Discovery Mission 16	ESS	09/01/18	10/01/23	--
Mars Scouts 2018	ESS	05/07/18	06/01/22	--
Mars Upper Atmosphere Orbiter (Mars Aeronomy)	ESS	05/17/18	06/01/21	--
Mars Sample Return	ESS	06/06/20	07/01/24	--
Europa Lander	ESS	04/01/20	04/01/26	--
Titan Explorer	ESS	02/01/19	02/01/29	--
Time History of Events and Macroscale Interactions during Substorms	SEC	04/01/07	05/01/09	06/01/10
Magnetospheric Multiscale (MMS)	SEC	07/01/09	07/01/11	07/01/12
Solar Probe	SEC	05/26/10	07/18/17	07/18/21

# DSN User / Future Mission Planning Set (cont.)

**2006 - 2030**

## FUTURE NASA PROJECTS

Project	Code S Theme	Launch or Start	EOPM	EOEM
Magnetospheric Constellation (MAGCON)	SEC	09/01/12	08/31/14	08/31/15
Telemachus	SEC	01/01/12	01/01/24	01/01/27
Heliospheric Imager and Galactic Observer	SEC	01/01/14	09/27/18	--
Inner Heliosphere Sentinels	SEC	01/01/09	01/31/14	--
Interstellar Probe	SEC	09/01/20	01/01/37	01/01/45
Solar Polar Imager	SEC	02/15/15	08/15/22	08/15/25
IO Electrodynamics	SEC	01/01/17	01/01/23	--
Stellar Imager	SEC	01/01/19	01/01/24	01/01/29
Solar Connections Observatory For Planetary Environs (SCOPE)	SEC	01/01/16	01/01/21	01/01/26
Particle Acceleration Solar Orbiter (PASO)	SEC	01/01/14	01/01/22	--
Neptune Orbiter	SEC	01/01/23	01/01/37	--
L1-Diamond	SEC	04/01/18	03/31/21	03/31/24



# DSN User / Future Mission Planning Set (cont.)

**2006 - 2030**

## FUTURE NASA PROJECTS

Project	Code S Theme	Launch or Start	EOPM	EOEM
Solar Imaging Radio Array (SIRA)	SEC	06/01/18	06/01/23	--
Sun-Heliosphere-Earth Constellation	SEC	01/01/26	01/01/36	01/01/41
Venus Aeronomy	SEC	06/01/19	06/01/21	--
Space Technology-9 (ST-9)	NMP	01/01/09	01/01/10	--

## FUTURE INTERNATIONAL MISSION SUPPORT

Project	Agency	Launch or Start	EOPM	EOEM
Bepi-Colombo	ESA	06/24/09	06/24/14	--
Herschel	ESA	02/01/07	12/31/10	--
Planck	ESA	02/01/07	12/31/09	--
Venus Express	ESA	06/01/06	06/01/09	--
Solar Obiter	ESA	01/01/10	01/01/13	--
GAIA	ESA	01/01/12	01/01/17	01/01/22

* New Frontier Missions				
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